GOETHE'S THEORY OF COLORS.

From an exposition given before the St. Louis Philosophical Society, Nov. 2nd, 1866.

I.—Color arises through the reciprocal action of light and darkness.

(*a.*) When a light object is seen through a medium that dims it, it appears of different degrees of yellow; if the medium is dark or dense, the color is orange, or approaches red. Examples: the sun seen in the morning through a slightly hazy atmosphere appears yellow, but if the air is thick with mist or smoke the sun looks red.

(*b.*) On the other hand a dark object, seen through a medium slightly illuminated, looks blue. If the medium is very strongly illuminated, the blue approaches a light blue; if less so, then indigo; if still less, the deep violet appears. Examples: a mountain situated at a great distance, from which very few rays of light come, looks blue, because we see it through a light medium, the air illuminated by the sun. The sky at high altitudes appears of a deep violet; at still higher ones, almost perfectly black; at lower ones, of a faint blue. Smoke—an illuminated medium—appears blue against a dark ground, but yellow or fiery against a light ground.

(*c.*) The process of bluing steel is a fine illustration of Goethe's theory. The steel is polished so that it reflects light like a mirror. On placing it in the charcoal furnace a film of oxydization begins to form so that the light is reflected through this dimming medium; this gives a straw color. Then, as the film thickens, the color deepens, passing through red to blue and indigo.

(*d.*) The prism is the grand instrument in the experimental field of research into light. The current theory that light, when pure, is composed of seven colors, is derived from supposed actual verifications with this instrument. The Goethean explanation is by far the simplest, and, in the end, it propounds a question which the Newtonian theory cannot answer without admitting the truth of Goethe's theory.

II.—The phenomenon of refraction is produced by interposing different transparent media between the luminous object and the illuminated one, in such a manner that there arises an apparent displacement of one of the objects as viewed from the other. By means of a prism the displacement is caused to lack uniformity; one part of the light image is displaced more than another part; several images, as it were, being formed with different degrees of displacement, so that they together make an image whose edges are blurred in the line of displacement. If the displacement were perfectly uniform, no color would arise, as is demonstrated by the achromatic prism or lens. The difference of degrees of refraction causes the elongation of the image into a spectrum, and hence a mingling of the edges of the image with the outlying dark surface of the wall, (which dark surface is essential to the production of the ordinary spectrum). Its *rationale* is the following:

(*a*) The light image refracted by the prism is extended over the dark on one side, while the dark on the other side is extended over it.

(*b*) The bright over the dark produces the blue in different degrees. The side nearest the dark being the deepest or violet, and the side nearest the light image being the lightest blue.

(*c*) On the other side, the dark over light produces yellow in different degrees; nearest the dark we have the deepest color, (orange approaching to red) and on the side nearest the light, the light yellow or saffron tint.

(*d*) If the image is large and but little refracted (as with a water prism) there will appear between the two opposite colored edges a colorless image, proving that the colors arise from the mingling of the light and dark edges, and not from any peculiar property of the prism which should "decompose the ray of light," as the current theory expresses it. If the latter theory

were correct the decomposition would be throughout, and the whole image be colored.

(*e*) If the image is a small one, or it is very strongly refracted, the colored edges come together in the middle, and the mingling of the light yellow with the light blue produces *green*—a new color which did not appear so long as the light ground appeared in the middle.

(*f*) If the refraction is still stronger, the edges of the opposite colors lap still more, and the green vanishes. The Newtonian theory cannot explain this, but it is to be expected according to Goethe's theory.

(*g*) According to Goethe's theory, if the object were a dark one instead of a light one, and were refracted on a light surface, the order of colors would be reversed on each edge of the image. This is the same experiment as one makes by looking through a prism at the bar of a window appearing against the sky. Where in the light image we had the yellow colors we should now expect the blue, for now it is dark over light where before it was light over dark. So, also, where we had blue we should now have yellow. This experiment may be so conducted that the current doctrine that violet is refracted the most, and red the least, shall be refuted.

(*h*) This constitutes the *experimentum crucis*. If the prism be a large water prism, and a black strip be pasted across the middle of it, parallel with its axis, so that in the midst of the image a dark shadow intervenes, the spectrum appears inverted in the middle, so that the red is seen where the green would otherwise appear, and those rays supposed to be the least refrangible are found refracted the most.

(*i*) When the two colored edges do not meet in this latter experiment, we have blue, indigo, violet, as the order on one side; and on the other, orange, yellow, saffron; the deeper colors being next to the dark image. If the two colored edges come together the union of the orange with the violet produces the perfect red (called by Goethe "*purpur*").

(*j*) The best method of making experiments is not the one that Newton employed—that of a dark room and a pencil of light—but it is better to look at dark and bright stripes on grounds of the opposite hue, or at the bars of a window, the prism being held in the hand of the investigator. In the Newtonian form of the experiment one is apt to forget the importance of the dark edge where it meets the light.

[For further information on this interesting subject the English reader is referred to Eastlake's translation of Goethe's Philosophy of Colors, published in London.]